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Full Length Research Paper

Amendment of crude oil contaminated soil with sawdust and chromoleana leaves for optimum plant protection

Offor, U.S. and Akonye, L.A.

Department of Plant Science and Biotechnology, Faculty of Science, University of Port Harcourt, Port Harcourt, Nigeria.

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A study on the effectiveness of sawdust and chromoleana leaves as soil restorative measures to optimize plant growth at two intensities of crude oil contamination showed that both restore parity on the growth parameters (leaf area, leaf ratio, relative leaf growth rate, relative growth rate, and net assimilation rate) of crops tested compared to control. However, chromoleana leaves was found to be more effective than sawdust. The test crops *Zea mays* and *Vigna unguiculata* differed with respect to their response to amendments applied. *V. unguiculata* showed better response than *Z. mays* in most of the parameters tested.

Key word: oil contamination, soil amendments, Bioremediation and plants growth.

INTRODUCTION

The extraction of crude oil has a double impact on climatic change and its ecosystem. The effect on plants can be related to its short and long term toxicities, persistence and dispersion properties. Hence there is a need for control and protection. Various methods of protecting plants against problems created by oil contamination include use of sorbent materials, chemical dispersants and burning. Most of these methods have undesirable ecological effects both on the crop and the environment (Jones and Greenfield, 1981). Therefore, protecting the plants with vegetative components that forms part of the environment becomes necessary (Gelta et al., 2004; Lin and Mendelssohn, 2004).

The use of sawdust and chromoleana leaves as part of bioremediative measures in crude oil contaminated soil has been previously studied (Akonye and Onwudiwe, 2004). Sawdust is a component of plant's vegetation derived from sawing wood and has been found to be an excellent material in particle board making, and from literature, possess those chemical/biological characteristics capable of amending polluted soil (Holf, 1992). *Chromoleana odorata* (L) R.M. King and Robinson popularly known as a stubborn weed, has been shown from recent finding to be useful in soil fertility restoration by providing essential constituents needed for plants growth and protection (Hoevers and Loob, 1996). It is against this background that this paper sought to explore the diverse qualities of sawdust and chromoleana leaves in protecting plants against crude oil contamination.

MATERIAL AND METHODS

The seeds of *Zea mays* were procured from the Green River Project (Extension division) of the Nigerian Agip Oil Company, while *Vigna unguiculata* was supplied by the Agricultural Development Project (ADP) both in Rivers State, Nigeria. The crude oil used was obtained from the Nigerian Agip Oil Company (NAOC) Ebocha Base, Port Harcourt. Polythene bags measuring 45 cm x 45 cm were perforated with three to five (3-5) small holes to allow easy drainage. They were filled with top soil collected from the botanical garden of University of Port Harcourt weighing 6,600 g leaving a space of 7.0 cm from the top to make allowance for addition of crude oil, the vegetative components and water.

Pollution of the soil was carried out in two intensities – densely and mildly polluted levels. In densely polluted treatments, 400 ml of crude oil was added and thoroughly mixed with the soil using a hand trowel and this represent 6% pollution by weight. While for

*Corresponding authors E-mail: sos2212003@yahoo.com.

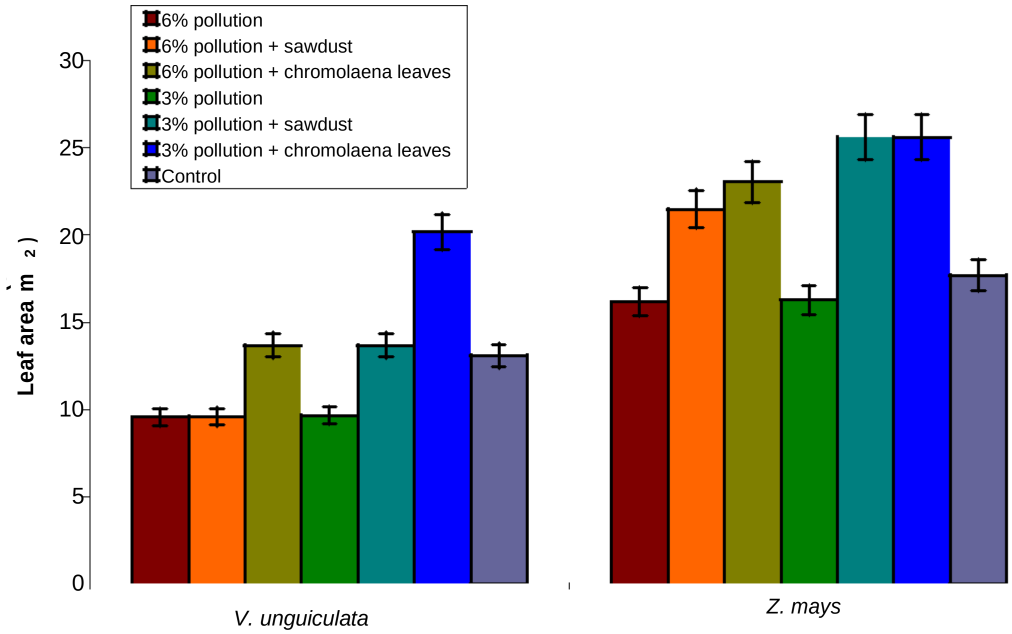

Figure 1. Effect of treatments on leaf area of *V. unguiculata* and *Z. mays*.

mildly polluted treatments, 200 ml was mixed with the same quantity of soil representing 3% pollution by weight. In the control, no crude oil was applied.

The sawdust and chromolaena leaves were weighed approximately 50 g each and applied to both densely and mildly conditions. The leaves were chopped with knife to ease mixing. After application, the vegetative components were left for a period of about 60 days before planting was undertaken. The experimental setup consists of the following:

Control
3% pollution
3% pollution + sawdust
3% pollution + chromolaena leaves
6% pollution
6% pollution + sawdust
6% pollution + chromolaena leaves

The growth indices used were leaf area (LA), leaf area ratio (LAR), relative leaf growth rate (RLGR), relative growth rate (RGR) and net assimilation rate (NAR). The leaf area was determined according to the methods of Adamson et al. (1980), leaf area ratio, relative leaf growth rate and relative growth rate was calculated using the formular of West et al. (1920), while net assimilation rate was calculated using, Williams (1964) formula. Data collected at two weeks interval were analyzed using Anova and Duncan multiply range test (DMRT) according to statistical analysis system (SAS 1991).

RESULTS

Leaf area (LA)

The leaf area of the crops was enhanced at mild oil concentration than severe with application of the vegetative components (Figure 1) . In *V. unguiculata*, presence of chromolaena leaves at 3% and 6% pollution showed preference than sawdust in LA. The leaf area of the crop was in inhibited at both pollution levels untreated compared to control.

With *Z. mays*, both amendments were compatible in LA promotion at both pollution levels compared to control. Equally, there was no significant difference in LA of *Z. mays* at control and untreated soils.

Leaf area ratio (LAR)

The LAR of the plants (Figure 2), showed remarkable improvement with application of the vegetative components at both pollution levels than control and untreated soils. However, while LAR of *V. unguiculata* was significantly higher at a lower oil concentration with application of chromolaena leaves in that of *Z. mays*, LAR increased greatly at 6% pollution with chromolaena leaves than other treatments.

Relative leaf growth rate (RLGR)

In Figure 3, the RLGR of *V. unguiculata* were inhibited at both pollution levels untreated and in a higher oil concentration with sawdust. The result with *Z. mays* showed similar inhibitory response at 6% pollution and treatment with chromolaena leaves compared to the control. Similarly, there was no significant difference in

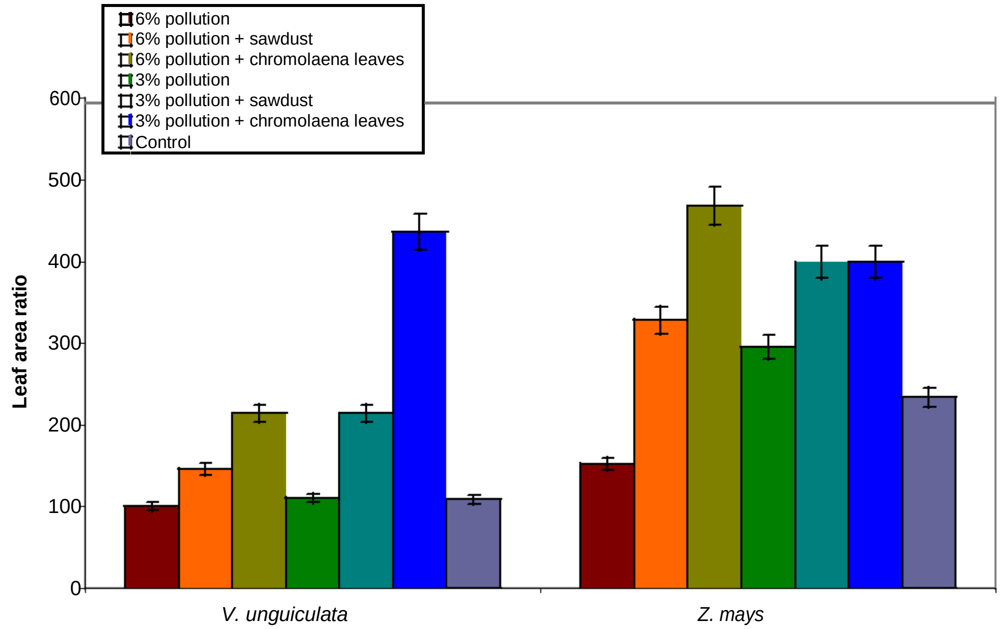

Figure 2. Effects of treatments on leaf area ratio of *V. unguiculata* and *Z. mays*.

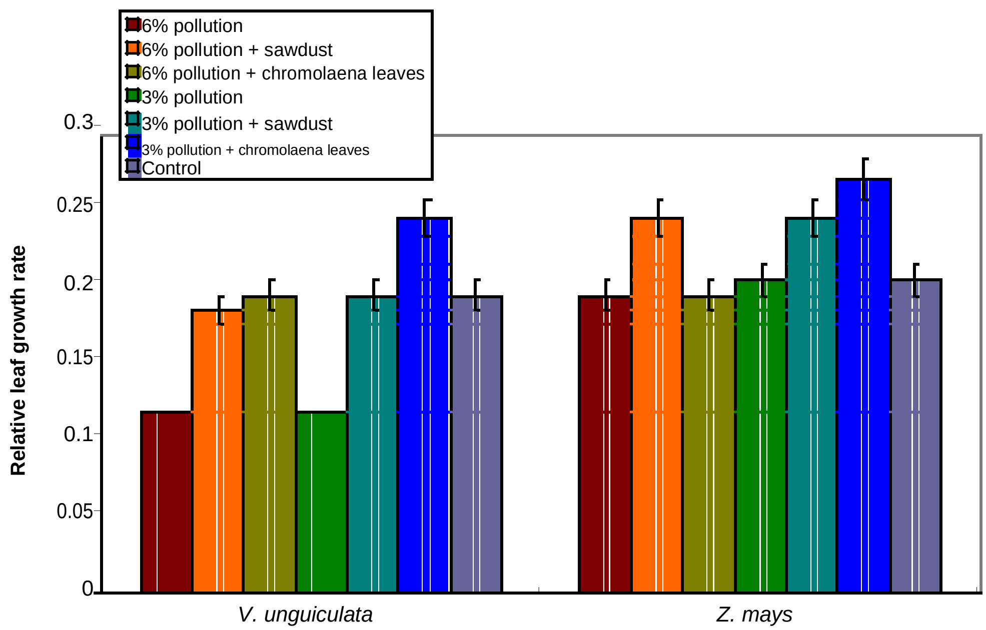

Figure 3. Effects of Treatments on Relative Leaf Growth Rate of *V. unguiculata* and *Z. mays*.

RLGR of the crop at a lower oil concentration untreated and control.

Relative growth rate (RGR)

In contrast to the control (Figure 4), the relative growth rates of *V. unguiculata* were inhibited in all treatments except with application of chromolaena leaves at a lower oil concentration. Equally application of chromolaena leaves at a higher oil concentration showed no significant difference in RGR of the crop compared to treatments with sawdust at 3% pollution. RGR was highly inhibited at a lower oil concentration untreated and 6% pollution plus sawdust. In *Z. mays,* the RGR were less significant.

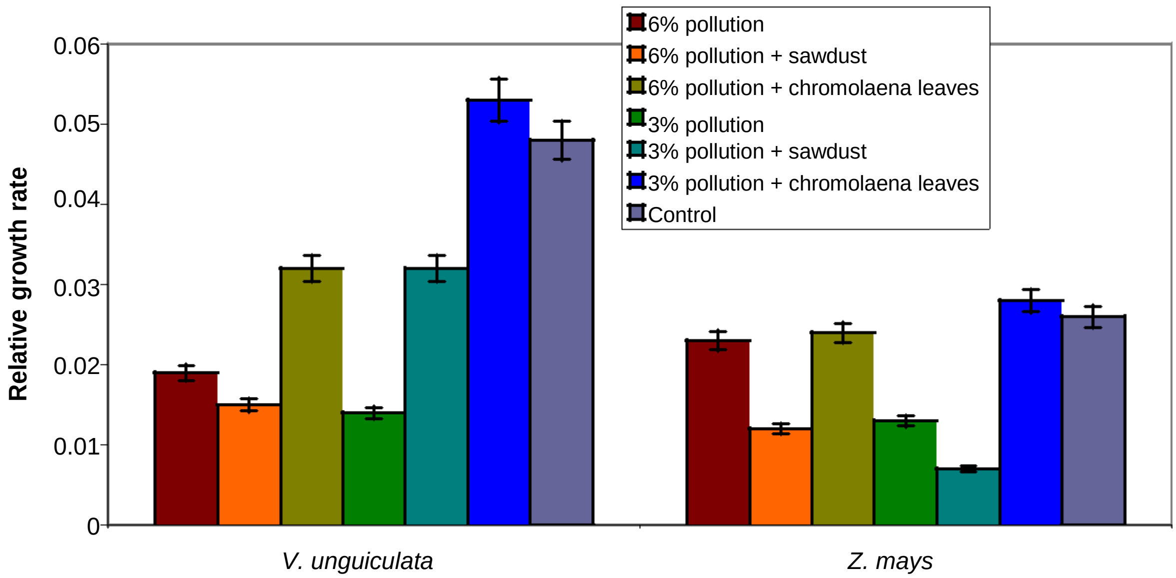

Figure 4. Effect of Treatments on Relative Growth Rate of V. unguiculata and *Z. mays*

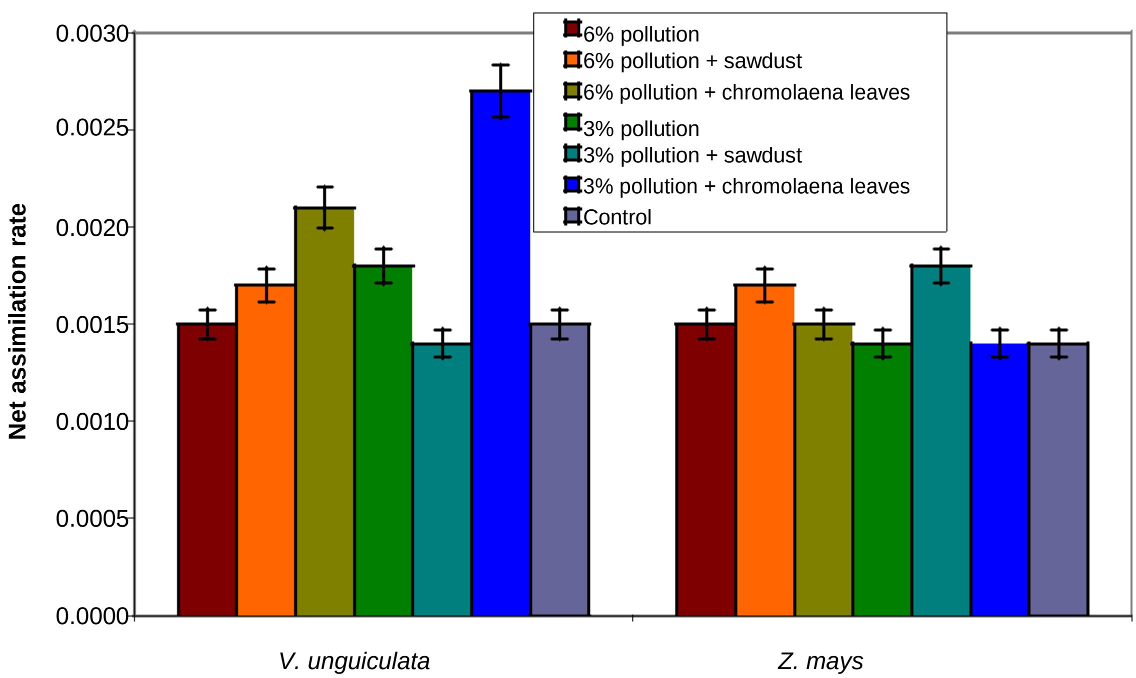

Figure 5. Effect of Treatments on Net Assimilation Rate of V. unguiculata and Z. mays

Net assimilation rate (NAR)

From the results (Figure 5), both untreated and treated soils with vegetative components were significant in NAR of the crops compared to the control, but chromolaena leaves showed preference than sawdust at all levels of pollution.

DISCUSSION

The addition of the vegetative components significantly improved the growth of *Z. mays* and *V. unguiculata* at both intensities of crude oil pollution especially at a lower oil concentration. This shows that sawdust and chromolaena leaves are beneficial in protecting and limiting the toxicity of oil contamination to plants. In other words, the level of oil contamination determined the amount of sawdust and chromolaena leaves to be used. The protective potential of similar vegetative components has previously being identified (Boyajian and Carreira, 1997; Chen and Lee, 1997; Ellis et al., 1990; Akonye and Onwudiwe, 2004).

That the ability of the vegetative components to protect the growth of the crop will sometimes depend on the genetic and physiological characteristics of the plants and soil condition. It is then postulated that the abilities of sawdust and chromolaena leaves to protect the plants will vary between crops. In *Z. mays,* for example, application of sawdust and chromolaena leaves significantly enhanced the leaf area and relative leaf growth rate. The net assimilation rate showed significant improvement with presence of sawdust at a lower oil concentration than chromolaena leaves and this may be related to the ability of sawdust to absorb oil films thereby reducing the toxically effects of the contaminants (Huang et al., 1998). The leaf area ratio of *Z. mays* was equally promoted at 3% pollution with chromolaena leaves while sawdust enhanced the relative growth rate of the crop comparable to the control. The variations between the two vegetative components at the two pollutions treatments to optimize plants growth may be related to their different degradation rates that accounts for the rate of biochemical constituents released into the soil.

The fact that the growth indices used in the study seem to be facilitated more in *V. unguiculata* than *Z. mays* with or without presence of amendments implies that these crops has natural variations in their ecological and biological characteristics. For instance, *V. unguiculata* as a legume have bacteria inhabiting its root nodules which might have aided in the degradation of hydrocarbon (crude oil) thereby protecting the crop (Entry et al., 1997) than *Z. mays.* The result of this study, from the physiological view, indicates that sawdust and chromolaena leaves, has potentials for protecting and maintaining optimum growth for plants in a polluted environment.

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